

Especially designed or prepared supersonic expansion nozzles for cooling mixtures of UF₆ and carrier gas to 150 K or less which are corrosion resistant to UF₆.

(6) Uranium pentafluoride product collectors (MLIS).

Especially designed or prepared uranium pentafluoride (UF₅) solid product collectors consisting of filter, impact, or cyclone-type collectors, or combinations thereof, which are corrosion resistant to the UF₅/UF₆ environment.

(7) UF₆/carrier gas compressors (MLIS).

Especially designed or prepared compressors for UF₆/carrier gas mixtures, designed for long term operation in a UF₆ environment. Components of these compressors that come into contact with process gas are made of or protected by materials resistant to UF₆ corrosion.

(8) Rotary shaft seals (MLIS).

Especially designed or prepared rotary shaft seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor rotor with the driver motor to ensure a reliable seal against out-leakage of process gas or in-leakage of air or seal gas into the inner chamber of the compressor which is filled with a UF₆/carrier gas mixture.

(9) Fluorination systems (MLIS).

Especially designed or prepared systems for fluorinating UF₅ (solid) to UF₆ (gas).

These systems are designed to fluorinate the collected UF₅ powder to UF₆ for subsequent collection in product containers or for transfer as feed to MLIS units for additional enrichment. In one approach, the fluorination reaction may be accomplished within the isotope separation system to react and recover directly off the “product” collectors. In another approach, the UF₅ powder may be removed/transferred from the “product” collectors into a suitable reaction vessel (e.g., fluidized-bed reactor, screw reactor or flame tower) for fluorination. In both approaches equipment is used for storage and transfer of fluorine (or other suitable fluorinating agents) and for collection and transfer of UF₆.

(10) UF₆ mass spectrometers/ion sources (MLIS).

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking “on-line” samples of feed, “product” or “tails”, from UF₆ gas streams and having all of the following characteristics:

(i) Unit resolution for mass greater than 320;

(ii) Ion sources constructed of or lined with nichrome or monel or nickel plated;

(iii) Electron bombardment ionization sources; and

(iv) Collector system suitable for isotopic analysis.

(11) Feed systems/product and tails withdrawal systems (MLIS).

Especially designed or prepared process systems or equipment for enrichment plants made of or protected by materials resistant to corrosion by UF₆, including:

(i) Feed autoclaves, ovens, or systems used for passing UF₆ to the enrichment process;

(ii) Desublimers (or cold traps) used to remove UF₆ from the enrichment process for subsequent transfer upon heating;

(iii) Solidification or liquefaction stations used to remove UF₆ from the enrichment process by compressing and converting UF₆ to a liquid or solid; and

(iv) “Product” or “tails” stations used to transfer UF₆ into containers.

(12) UF₆/carrier gas separation systems (MLIS).

Especially designed or prepared process systems for separating UF₆ from carrier gas. The carrier gas may be nitrogen, argon, or other gas.

These systems may incorporate equipment such as:

(i) Cryogenic heat exchangers or cryoseparators capable of temperatures of –120°C or less;

(ii) Cryogenic refrigeration units capable of temperatures of –120°C or less; or

(iii) UF₆ cold traps capable of temperatures of –20°C or less.

(13) Lasers or Laser systems (AVLIS, MLIS and CRISLA).

Especially designed or prepared for the separation of uranium isotopes. The laser system for the AVLIS process usually consists of two lasers: a copper vapor laser and a dye laser. The laser system for MLIS usually consists of a CO₂ or excimer laser and a multi-pass optical cell with revolving mirrors at both ends. Lasers or laser systems for both processes require a spectrum frequency stabilizer for operation over extended periods.

[61 FR 35605, July 8, 1996]

APPENDIX G TO PART 110—ILLUSTRATIVE LIST OF PLASMA SEPARATION ENRICHMENT PLANT EQUIPMENT AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—In the plasma separation process, a plasma of uranium ions passes through an electric field tuned to the 235U ion resonance frequency so that they preferentially absorb energy and increase the diameter of their corkscrew-like orbits. Ions with a large-diameter path are trapped to produce a product enriched in 235U. The plasma, made by ionizing uranium vapor, is contained in a vacuum chamber with a high-strength magnetic field produced by a superconducting magnet. The main technological systems of the process include the uranium plasma generation system, the separator module with superconducting magnet, and metal removal

systems for the collection of "product" and "tails".

(1) Microwave power sources and antennae.

Especially designed or prepared microwave power sources and antennae for producing or accelerating ions having the following characteristics: greater than 30 GHz frequency and greater than 50 kW mean power output for ion production.

(2) Ion excitation coils.

Especially designed or prepared radio frequency ion excitation coils for frequencies of more than 100 kHz and capable of handling more than 40 kW mean power.

(3) Uranium plasma generation systems.

Especially designed or prepared systems for the generation of uranium plasma, which may contain high power strip or scanning electron beam guns with a delivered power on the target of more than 2.5 kW/cm.

(4) Liquid uranium metal handling systems.

Especially designed or prepared liquid metal handling systems for molten uranium or uranium alloys, consisting of crucible and cooling equipment for the crucibles.

The crucibles and other system parts that come into contact with molten uranium or uranium alloys are made of or protected by corrosion and heat resistance materials, such as tantalum, yttria-coated graphite, graphite coated with other rare earth oxides or mixtures thereof.

(5) Uranium metal "product" and "tails" collector assemblies.

Especially designed or prepared "product" and "tails" collector assemblies for uranium metal in solid form. These collector assemblies are made of or protected by materials resistant to the heat and corrosion of uranium metal vapor, such as yttria-coated graphite or tantalum.

(6) Separator module housings.

Especially designed or prepared cylindrical vessels for use in plasma separation enrichment plants for containing the uranium plasma source, radio-frequency drive coil and the "product" and "tails" collectors.

These housings have a multiplicity of ports for electrical feed-throughs, diffusion pump connections and instrumentation diagnostics and monitoring. They have provisions for opening and closure to allow for refurbishment of internal components and are constructed of a suitable non-magnetic material such as stainless steel.

[61 FR 35606, July 8, 1996]

APPENDIX H TO PART 110—ILLUSTRATIVE LIST OF ELECTROMAGNETIC ENRICHMENT PLANT EQUIPMENT AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—In the electromagnetic process, uranium metal ions produced by ionization of a

salt feed material (typically UCL4) are accelerated and passed through a magnetic field that has the effect of causing the ions of different isotopes to follow different paths. The major components of an electromagnetic isotope separator include: a magnetic field for ion-beam diversion/separation of the isotopes, an ion source with its acceleration system, and a collection system for the separated ions. Auxiliary systems for the process include the magnet power supply system, the ion source high-voltage power supply system, the vacuum system, and extensive chemical handling systems for recovery of product and cleaning/recycling of components.

(1) Electromagnetic isotope separators.

Especially designed or prepared for the separation of uranium isotopes, and equipment and components therefor, including:

(i) Ion Sources—especially designed or prepared single or multiple uranium ion sources consisting of a vapor source, ionizer, and beam accelerator, constructed of materials such as graphite, stainless steel, or copper, and capable of providing a total ion beam current of 50 mA or greater;

(ii) Ion collectors—collector plates consisting of two or more slits and pockets especially designed or prepared for collection of enriched and depleted uranium ion beams and constructed of materials such as graphite or stainless steel;

(iii) Vacuum housings—especially designed or prepared vacuum housings for uranium electromagnetic separators, constructed of suitable non-magnetic materials such as stainless steel and designed for operation at pressures of 0.1 Pa or lower.

The housings are specially designed to contain the ion sources, collector plates and water-cooled liners and have provision for diffusion pump connections and opening and closure for removal and reinstallation of these components; and

(iv) Magnet pole pieces—especially designed or prepared magnet pole pieces having a diameter greater than 2 m used to maintain a constant magnetic field within an electromagnetic isotope separator and to transfer the magnetic field between adjoining separators.

(2) High voltage power supplies.

Especially designed or prepared high-voltage power supplies for ion sources, having all of the following characteristics:

(i) Capable of continuous operation;

(ii) Output voltage of 20,000 V or greater;

(iii) Output current of 1 A or greater; and

(iv) Voltage regulation of better than 0.01% over an 8 hour time period.

(3) Magnet power supplies.

Especially designed or prepared high-power, direct current magnet power supplies having all of the following characteristics: